SYLLABUS

Linear Algebra, Analytical and Differential Geometry 2

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	**"Babeș-Bolyai" University Cluj Napoca**
1.2. Faculty	**Mathematics and Computer Science**
1.3. Department	**Mathematics**
1.4. Field of study	**Computer Science**
1.5. Study cycle	**Bachelor**
1.6. Study programme/Qualification	**Information Engineering, English**
1.7. Form of education	**Regular attendance**

2. Information regarding the discipline

2.1. Name of the discipline	**Linear Algebra, Analytical and Differential Geometry 2**					Discipline code	**MLE0089**
2.2. Course coordinator				**Conf. dr. Paul Blaga**			
2.3. Seminar coordinator				**Conf. dr. Paul Blaga**			
2.4. Year of study	1	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Discipline regime	DF

3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	**4**	of which: 3.2 course	**3**	3.3 seminar/laboratory/project	**1**
3.4. Total hours in the curriculum	56	of which: 3.5 course	42	3.6 seminar/laboratory/project	**14**

Time allotment for individual study (ID) and self-study activities (SA)	**hours**
Learning using manual, course support, bibliography, course notes (SA)	20
Additional documentation (in libraries, on electronic platforms, field documentation)	20
Preparation for seminars/labs, homework, papers, portfolios and essays	20
Tutorship	5
Evaluations	4
Other activities:	0
3.7. Total individual study hours	**69**
3.8. Total hours per semester	**125**
3.9. Number of ECTS credits	**5**

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	Elementary knowledge of linear algebra, geometry and trigonometry

5. Conditions (if necessary)

5.1. for the course	A lecture hall with videoprojector
5.2. for the seminar /lab activities	

6.1. Specific competencies acquired [1]

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

Professional/essential competencies	• Using the specific terminology of analytic and differential geometry in various contexts of application, processing quantitative, qualitative, structural or contextual data specific to analytic and differential geometry contained in mathematical statements, using the algorithms specific to analytic and differential geometry and the concepts of analytic and differential geometry in solving problems , expressing and coherently writing in formal language the solution of a geometry problem , analysis of problem situations in order to identify strategies for optimizing solutions, generalizing some properties specific to l geometry by modifying the initial context of defining the problem or by generalizing the algorithms
Transversal competencies	• Learning skills, communication skills, social skills

6.2. Learning outcomes

Knowledge	The student knows: the fundamentals of analytic and differential geometry.
Skills	The student is able to solve problems of analytic and differential geometry.
Responsibility and autonomy:	The student has the ability to work independently to obtain models based on analytic and differential geometry and to analyse them.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• developing creative thinking, developing calculation skills, developing spatial vision, forming a pro-active attitude towards geometry developing independent learning skills
7.2 Specific objective of the discipline	• The purpose of the course is to familiarize the students of Information Engineering with the main notions and methods of analytic and differential geometry, taking into account, above all, the possible applications in computer graphics and geometric design assisted by computer, as well as in applications related to virtual reality.

8. Content

8.1 Course	Teaching methods	Remarks
Vector algebra, coordinate systems	Lecture, description, exemplification using multimedia tools.	
The straight line (in the plane and in space), the plane	Lecture, description, exemplification using multimedia tools.	
Conical sections	Lecture, description, exemplification using multimedia tools.	
Generated surfaces	Lecture, description, exemplification using multimedia tools.	
Quadric surfaces	Lecture, description, exemplification using multimedia tools.	
Homogeneous coordinates, 2d affine transformations	Lecture, description, exemplification using multimedia tools.	
3d affine transformations and projections	Lecture, description, exemplification using multimedia tools.	
Parameterized curves, the tangent and the normal plane, the normal to a plane curve, the osculating plane	Lecture, description, exemplification using multimedia tools.	
The Frenet frame of a space curve, the Frenet equations, the curvature and the torsion, intrinsic equations	Lecture, description, exemplification using multimedia tools.	
Plane curves, signed curvature, envelopes, evolvent and involvent of a plane curve, intrinsic equation	Lecture, description, exemplification using multimedia tools.	
Parametrized surfaces, curves on a surface, tangent plane and normal to a surface	Lecture, description, exemplification using multimedia tools.	
The first fundamental form of a surface and applications to the computation of lengths, angles and areas	Lecture, description, exemplification using multimedia tools.	
The Gauss map and the second fundamental form of s surface, classification of the points of a surface, asymptotic lines and curvature line	Lecture, description, exemplification using multimedia tools.	
The curvatures of a surface (normal, principal, total, mean), geodesic lines	Lecture, description, exemplification using multimedia tools.	

Bibliography

1. Dorin Andrica, Liana Ţopan -- Analytic Geometry, Cluj University Press, 2004

2. Michele Audin – Geometry, Springer, 2003
3. Paul A. Blaga – Geometrie liniară, cu un ochi către grafica pe calculator, vol. I, Presa Universitară Clujeană, 2022
4. Paul A. Blaga – Lectures on Classical Differential Geometry, Risoprint, 2005
5. John Oprea – Differential Geometry and its Applications (2nd edition), Mathematical Association of America, 2007
6. A. Pogorelov – Analytical Geometry, Mir Publishers, 1980
7. A. Pogorelov – Geometry, Mir Publishers, 1987
8. D. Rogers, J. Adams – Mathematical Elements for Computer Graphics (2nd edition), McGraw Hill, 1990

8.2 Seminar / laboratory	Teaching methods	Remarks
Problems with vectors, lines and planes	Description, explanation, conversation, individual study and / or teamwork.	
Problems with conical sections	Description, explanation, conversation, individual study and / or teamwork.	
Problems with quadrics and generated surfaces	Description, explanation, conversation, individual study and / or teamwork.	
Problems with affine transformations and projections	Description, explanation, conversation, individual study and / or teamwork.	
Problems related to the differential geometry of curves	Description, explanation, conversation, individual study and / or teamwork.	
Problems with surfaces (tangent plane, normal, the first fundamental form)	Description, explanation, conversation, individual study and / or teamwork.	
Problems with surfaces (the second fundamental form, curvatures, special families of lines)	Description, explanation, conversation, individual study and / or teamwork.	

Bibliography

1.Cristina Blaga, Paul A. Blaga – Geometrie analitică, culegere de probleme, Presa Universitară Clujeană, 2023

2. A. .Fedenko -- Recueil d'exercices de geometrie differentielle, Ed. MIR, 1982

3.T. Fomenko, A.S. Mishchenko, Yu. Soloyev – Selected Problems in Differential Geometry and Topology, Cambridge Scientific Publishers, 2013

4. D. Kletenik – Problems in Analytic Geometry, Mir Publishers, 1969

1. 5. M. Lipschutz – Schaum's Outline of Differential Geometry, McGraw Hill, 1969

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The material of the course will prove useful in courses of algorithms (especially computational geometry) and it is necessary prerequisite for any serious course of Computer Graphics, CAGD or Computer Vision and Virtual Reality.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	The completeness and correctness of the knowledge	Exam	3/5
	The degree of assimilation of the specialized language		
10.5 Seminar/laboratory	The ability to use the assimilated knowledge in solving problems	Midterm exam, Continuous evaluation of student participation in educational activities	2/5
	Analytical capacity, originality		
10.6 Minimum standard of performance			
• The minimum passing grade is 5, for both course and seminar.			

11. Labels ODD (Sustainable Development Goals)[2]

	Eticheta generală pentru Dezvoltare durabilă							
								

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable.*”.

Date:
April 25, 2025

Signature of course coordinator

Assoc. Prof. Paul Blaga

Signature of seminar coordinator

Assoc. Prof. Paul Blaga

Date of approval:
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Signature of the head of department

Prof. Andrei Mărcuș